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(21)Application number : 2000-173895 (71)Applicant : FUJI PHOTO FILM CO LTD

(22)Date of filing : 09.06.2000 (72)Inventor : YAMADA MAKOTO

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(54) IMAGE INPUT DEVICE USING SOLID-STATE IMAGE PICKUP ELEMENT AND IMAGE INPUT METHOD, AND RECORDING MEDIUM FOR RECORDING PROGRAM FOR THE METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an image input device that reduces a noise included in digital image data picked up by a solid-state image pickup element such as a CCD.

SOLUTION: This invention provides the image input device employing a solid-state image pickup element that captures an image as digital image data with a solid-state image pickup element, applies color correction to the data and records the processed data on an image recording medium, is characteristically provided with a lightness detection means that detects the lightness of each part in the captured image and with a matrix coefficient setting means that sets a coefficient of a color correction matrix of the color correction depending on the detected lightness of each part in the image so as to accomplish the above purpose.

CLAIMS

[Claim(s)]
[Claim 1]An image acquiring device characterized by comprising the following using a solid state image pickup device which captures an image as digital image data with a

solid state image pickup device, performs color correction processing, and is recorded on an image recording medium.
A brightness detection means to detect brightness of each part in said captured picture.
A matrix coefficient setting means which sets up a coefficient of a color correction matrix for performing said color correction processing according to brightness of each part in said detected picture.

[Claim 2]An image acquiring device using the solid state image pickup device according to claim 1 which said matrix coefficient setting means sets up an absolute value of a coefficient of said matrix greatly in a field where brightness of each part in said detected picture is high, and set up an absolute value of a coefficient of said matrix small in a field where brightness is low.
[Claim 3]Said matrix coefficient setting means changes a coefficient of a linear matrix and a color difference matrix according to a luminosity of each part in said picture as said color correction matrix, In a bright field in said detected picture, an absolute value of a coefficient of said linear matrix is set up greatly, An image acquiring device using the solid state image pickup device according to claim 1 which makes small an absolute value of a coefficient of said linear matrix in a dark field, and set up a coefficient of said color difference matrix greatly.
[Claim 4]An image acquiring device characterized by comprising the following using a solid state image pickup device which captures an image as digital image data with a solid state image pickup device, performs color correction processing, and is recorded on an image recording medium.
A sensitivity setting means which sets up sensitivity of said solid state image pickup device.
A matrix coefficient setting means which sets up a coefficient of a color correction matrix for performing said color correction processing according to sensitivity of said set-up solid state image pickup device.

[Claim 5]An image acquiring device using the solid state image pickup device according to claim 4 which set up an absolute value of a coefficient of said matrix greatly when said matrix coefficient setting means had low sensitivity of said set-up solid state image pickup device, and set up an absolute value of a coefficient of said matrix small when sensitivity was high.
[Claim 6]Said matrix coefficient setting means changes a coefficient of a linear matrix

and a color difference matrix according to sensitivity of said solid state image pickup device as said color correction matrix, When sensitivity of said set-up solid state image pickup device is low, an absolute value of a coefficient of said linear matrix is set up greatly, An image acquiring device using the solid state image pickup device according to claim 4 which makes small an absolute value of a coefficient of said linear matrix when sensitivity is high, and set up a coefficient of said color difference matrix greatly.
[Claim 7]. Capture an image as digital image data with a solid state image pickup device, perform color correction processing, and record on an image recording medium. An image acquisition method using a solid state image pickup device setting up a coefficient of a color correction matrix for being an image acquisition method using a solid state image pickup device, detecting brightness of each part in said captured picture, and performing said color correction processing according to brightness of each part in said detected picture.
[Claim 8]In a field where brightness of each part in said detected picture is high, an absolute value of a coefficient of said matrix is greatly set up for a coefficient of a color correction matrix for performing said color correction processing, An image acquisition method using the solid state image pickup device according to claim 7 which set up an absolute value of a coefficient of said matrix small in a field where brightness is low.
[Claim 9]A coefficient of a linear matrix which is a color correction matrix for performing said color correction processing, and a color difference matrix is changed according to a luminosity of each part in said picture, In a bright field in said detected picture, an absolute value of a coefficient of said linear matrix is set up greatly, An image acquisition method using the solid state image pickup device according to claim 7 which makes small an absolute value of a coefficient of said linear matrix in a dark field, and set up a coefficient of said color difference matrix greatly.
[Claim 10]. Capture an image as digital image data with a solid state image pickup device, perform color correction processing, and record on an image recording medium. An image acquisition method using a solid state image pickup device which is an image acquisition method using a solid state image pickup device, and is characterized by setting up a coefficient of a color correction matrix for performing said color correction processing according to sensitivity of said solid state image pickup device.
[Claim 11]When sensitivity of said solid state image pickup device is low, an absolute value of a coefficient of said matrix is greatly set up for a coefficient of a color

correction matrix for performing said color correction processing, An image acquisition method using the solid state image pickup device according to claim 10 which set up an absolute value of a coefficient of said matrix small when sensitivity was high.

[Claim 12]A coefficient of a linear matrix which is a coefficient of a color correction matrix for performing said color correction processing, and a color difference matrix is changed according to sensitivity of said solid state image pickup device, When sensitivity of said solid state image pickup device is low, an absolute value of a coefficient of said linear matrix is set up greatly, An image acquisition method using the solid state image pickup device according to claim 10 which sets up an absolute value of a coefficient of said linear matrix small when sensitivity is high, and set up a coefficient of said color difference matrix greatly.

[Claim 13]A recording medium which recorded a program for performing said image acquisition method which recorded an image acquisition method using the solid state image pickup device according to any one of claims 7 to 12 by computer as a program for performing a computer so that reading was possible.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]In the still picture input device this invention relates to the

recording medium which recorded the program for performing the image acquiring device which used the solid state image pickup device, an image acquisition method, and its method, and using CCD, such as a digital still camera, especially, It is related with the art of reducing the noise which increases when a photographic subject is dark.
[0002]
[Description of the Prior Art]The imaging device which photos a picture on a film like the conventional camera is replaced, For example, image acquiring devices, such as a digital still camera (digital camera) which change into digital image data the luminance signal which picturized and acquired the photographic subject using solid state image pickup devices, such as CCD, and is recorded on a recording medium, are known widely. The signal output of a digital camera is digital image data expressed with the digital value of 8 bits, for example.
It is incorporated into an image processing device (personal computer), and predetermined image processing is performed, it is displayed on the monitor of CRT etc. or this data is outputted as a print (hard copy) from a printer.

[0003]In the digital camera in which color image photographing is possible, various color correction processings were carried out to the signal generally outputted from CCD, and the final outputted image has been obtained. As this color correction processing, linear matrix processing, color difference matrix processing, etc. are known, for example. Here, linear matrix processing is performed by making the procession (linear matrix) of 3x3 act on the photographic subject luminosity outputted from CCD to a linear signal. on the other hand -- color difference matrix processing -- luminosity -- a luminance signal and a color-difference signal are searched for from the signal carried out, and a linear signal is made for gamma conversion to act [the procession (color difference matrix) of 2x2, etc.] on this color-difference signal according to the CRT monitor characteristic As these features, the linear matrix is advantageous in order to obtain exact color reproduction, and on the other hand, in order that a color difference matrix may not change a luminance signal the place where a luminance noise is conspicuous compared with color noises, it is advantageous in respect of a noise.
[0004]
[Problem(s) to be Solved by the Invention]By the way, generally the noise is contained in the signal outputted from CCD. As this noise component, the shot noise proportional to the square root of the incident light quantity to CCD and the dark current noise (fixed noise) of CCD independent of incident light quantity are dominant,

and it is known that the ratio of the noise contained in a signal, so that there is little light volume which enters especially into CCD will increase.
[0005]Here, the noise amplification effect becomes strong, so that said linear matrix and a color difference matrix have an effect which amplifies a noise and a value with a big absolute value of a matrix coefficient is taken. However, when the matrix fixed irrespective of the light volume which enters into CCD was being used for the present digital camera, and a noise was conspicuous by the dark space of a photographic subject and a sensitivity preset value was set up highly, there was a problem that a noise was conspicuous by the whole picture.
[0006]. This invention is made in view of said conventional problem, and the noise contained in the digital image data picturized by solid state image pickup devices, such as CCD, can be reduced. Let it be a technical problem to provide the recording medium which recorded the program for performing the image acquiring device using a solid state image pickup device, an image acquisition method, and its method.
[0007]
[Means for Solving the Problem]In order to solve said technical problem, the first mode of this invention, A brightness detection means to be an image acquiring device using a solid state image pickup device which captures an image as digital image data with a solid state image pickup device, performs color correction processing, and is recorded on an image recording medium, and to detect brightness of each part in said captured picture, An image acquiring device using a solid state image pickup device provided with a matrix coefficient setting means which sets up a coefficient of a color correction matrix for performing said color correction processing according to brightness of each part in said detected picture is provided.
[0008]As for said matrix coefficient setting means, in a field where brightness of each part in said detected picture is high, it is preferred to set up an absolute value of a coefficient of said matrix greatly, and to have set up an absolute value of a coefficient of said matrix small in a field where brightness is low.
[0009]Said matrix coefficient setting means changes a coefficient of a linear matrix and a color difference matrix according to a luminosity of each part in said picture as said color correction matrix, In a bright field in said detected picture, it is preferred to set up an absolute value of a coefficient of said linear matrix greatly, and to make small an absolute value of a coefficient of said linear matrix in a dark field, and to have set up a coefficient of said color difference matrix greatly.
[0010]In order to solve said technical problem similarly, the second mode of this invention, A sensitivity setting means which is an image acquiring device using a solid

state image pickup device which captures an image as digital image data with a solid state image pickup device, performs color correction processing, and is recorded on an image recording medium, and sets up sensitivity of said solid state image pickup device, An image acquiring device using a solid state image pickup device provided with a matrix coefficient setting means which sets up a coefficient of a color correction matrix for performing said color correction processing according to sensitivity of said set-up solid state image pickup device is provided.

[0011]As for said matrix coefficient setting means, it is preferred to have set up an absolute value of a coefficient of said matrix greatly, when sensitivity of said set-up solid state image pickup device was low, and to have set up an absolute value of a coefficient of said matrix small, when sensitivity was high.

[0012]Said matrix coefficient setting means changes a coefficient of a linear matrix and a color difference matrix according to sensitivity of said solid state image pickup device as said color correction matrix, It is preferred to set up an absolute value of a coefficient of said linear matrix greatly, when sensitivity of said set-up solid state image pickup device is low, to make small an absolute value of a coefficient of said linear matrix, when sensitivity is high, and to have set up a coefficient of said color difference matrix greatly.

[0013]In order to solve said technical problem similarly, the third mode of this invention, . Capture an image as digital image data with a solid state image pickup device, perform color correction processing, and record on an image recording medium. It is an image acquisition method using a solid state image pickup device, and brightness of each part in said captured picture is detected, and an image acquisition method using a solid state image pickup device setting up a coefficient of a color correction matrix for performing said color correction processing according to brightness of each part in said detected picture is provided.

[0014]It is preferred to set up an absolute value of a coefficient of said matrix for a coefficient of a color correction matrix for performing said color correction processing greatly in a field where brightness of each part in said detected picture is high, and to have set up an absolute value of a coefficient of said matrix small in a field where brightness is low.

[0015]A coefficient of a linear matrix which is a color correction matrix for performing said color correction processing, and a color difference matrix is changed according to a luminosity of each part in said picture, In a bright field in said detected picture, it is preferred to set up an absolute value of a coefficient of said linear matrix greatly, and to make small an absolute value of a coefficient of said linear matrix in a dark field, and

to have set up a coefficient of said color difference matrix greatly.

[0016]In order to solve said technical problem similarly, the fourth mode of this invention, . Capture an image as digital image data with a solid state image pickup device, perform color correction processing, and record on an image recording medium. It is an image acquisition method using a solid state image pickup device, and an image acquisition method using a solid state image pickup device setting up a coefficient of a color correction matrix for performing said color correction processing according to sensitivity of said solid state image pickup device is provided.

[0017]It is preferred to have set up an absolute value of a coefficient of said matrix for a coefficient of a color correction matrix for performing said color correction processing greatly, when sensitivity of said solid state image pickup device was low, and to have set up an absolute value of a coefficient of said matrix small, when sensitivity was high.

[0018]A coefficient of a linear matrix which is a coefficient of a color correction matrix for performing said color correction processing, and a color difference matrix is changed according to sensitivity of said solid state image pickup device, It is preferred to set up an absolute value of a coefficient of said linear matrix greatly, when sensitivity of said solid state image pickup device is low, to set up an absolute value of a coefficient of said linear matrix small, when sensitivity is high, and to have set up a coefficient of said color difference matrix greatly.

[0019]In order to solve said technical problem similarly, the fifth mode of this invention, A recording medium which recorded a program for performing said image acquisition method which recorded an image acquisition method using said solid state image pickup device by computer as a program for performing a computer so that reading was possible is provided.

[0020]

[Embodiment of the Invention]The recording medium which recorded the program for performing the image acquiring device using the solid state image pickup device concerning this invention, an image acquisition method, and its method hereafter is explained in detail based on the suitable embodiment shown in an attached drawing.

[0021]Drawing 1 is a block diagram showing the outline of the image acquiring device using the solid state image pickup device concerning one embodiment of this invention. The image acquiring device 10 of this embodiment is constituted including CCD12, the data processing part 14, the brightness primary detecting element 16, the sensitivity set part 18, the matrix coefficient set part 20, the color correction part 22, and the image output part 24.

[0022]CCD12 is an image sensor which can acquire a color picture, and assumes that it has a spectral sensitivity characteristic as shown in drawing 2. A solid line expresses B (blue), a dashed line expresses G (green), and a dashed dotted line expresses R (red) with drawing 2. The data processing part 14 carries out the A/D conversion of the picture signal inputted from CCD12, considers it as digital image data, and processes white balance correction and others. The brightness primary detecting element 16 detects the brightness of each part in a picture using the linear combination of the following formula (1) from R after white balance correction (gain correcting), G, and B signal.

$Y = 3xR + 6xG + B$ ... (1)

The sensitivity set part 18 sets up the sensitivity at the time of photography of CCD12, when a picture is dark, it sets up sensitivity highly, and when a picture is bright, it sets up sensitivity low.

[0023]The matrix coefficient set part 20 acquires the information from the brightness primary detecting element 16 or the sensitivity set part 18, and sets up the coefficient of the matrix for color correction (a linear matrix and color difference matrix) according to brightness or sensitivity. The color correction part 22 performs color correction processing to image data using the color correction matrix set up by the matrix set part 20. And processed image data is outputted to predetermined image recording media, such as a memory card, a hard disk, and an internal memory, from the image output part 24, corresponding to the purpose of using image data, etc.

[0024]Hereafter, an operation of this embodiment is explained. Here, when referred to as D65 to which a standard light source is specified by CIE, the reflectance of the ratio of the light exposure given to R and G which are 1.0, and which receive white, and B each channel on each wavelength is as follows.

R: 0.375G : 1.000B : 0.693, however these values are values standardized with the light exposure of G channel which gives a maximum exposure value.

[0025]It supposes that the saturation charge quantity of CCD12 is 20000e now, and since the given light exposure is proportional to the charge quantity to generate when the amount of output electric charges of the channel (G) which gives the maximum exposure value which receives white is made equal to saturation charge quantity, the generating charge quantity of each channel is as follows.

R: 7500eG: 20000eB: 13860e [0026]Here, if the noise generated in CCD12 assumes that it is determined by the shot noise Ns proportional to the square root of charge quantity, and the fixed noise Nd independent of charge quantity, noise volume N generated by each channel will be given by the following formula (2).

N = $^{(Ns2+Nd2)\ 1/2}$ ... (2)
However, when S is made into generating charge quantity, they are $Ns=S^{1/2}$.
[0027]Therefore, the noise volume of each channel when referred to as Nd=5e is as follows.
R: 86.7eG: 141.5eB: 117.8e -- here, in order to take a white balance, each of these channels are multiplied by the following gains.
R: 2.67G : 1.00B : 1.44, as a result the noise volume contained in each channel are as follows.
R: 231.3G: 141.5B: 170.0 [0028]Next, the linear matrix expressed with the following formulas (3) to signal value R=7500x2.67=20025G=20000x1.00=20000B=13860x1.44=19958 produced by multiplying by the above-mentioned gain to said each generating charge quantity is made to act.
[Equation 1]

$$\begin{pmatrix} R' \\ G' \\ B' \end{pmatrix} = \begin{pmatrix} 1.96 & -1.65 & 0.68 \\ 0.03 & 1.80 & -0.83 \\ -0.07 & -0.26 & 1.33 \end{pmatrix} \begin{pmatrix} R \\ G \\ B \end{pmatrix} \cdots (3)$$

As a result, the signal charge quantity of each channel is obtained as follows.
R'=19820G'=20035B'=19943 [0029]The noise volume contained in each channel is as follows from the ability to express with the square root of a square sum [respectively / (noise volume contained in R / before starting a linear matrix /, G, and B each channel)].
R: 522.9G: 291.3B: 229.7 [0030]When signal charge quantity of each channel i (i=R, G, B) is set to Ei and noise volume of each channel i is set to nickel, a ratio (S/N) of a signal and a noise is expressed with the following formula (4).
S/N = 20xLog (Ei/nickel) ... (4)
Then, it is as follows when a S/N ratio is calculated by finally using this.
R=20xLog (19820/522.9) = 31.7 G=20xLog(20035/291.3) =36.7 B=20xLog(19943/229.7) =38.8[0031]Next, the following result will be obtained if an object reflection factor performs the same calculation as a top to an object of 0.05 (5%) on each wavelength.
R: 18.4G : 23.6B : About a dark color of as [25.6, thus whose reflectance are 5%], it turns out that a noise increases and a S/N ratio falls greatly.
[0032]Here, as the absolute value is made smaller, for example, a coefficient of a

linear matrix is shown in the following formula (5) to the above-mentioned formula (3), it changes.
[Equation 2]

$$\begin{pmatrix} R' \\ G' \\ B' \end{pmatrix} = \begin{pmatrix} 1.00 & 0.00 & 0.00 \\ 0.00 & 1.00 & 0.00 \\ 0.00 & 0.00 & 1.00 \end{pmatrix} \begin{pmatrix} R \\ G \\ B \end{pmatrix} \cdots (5)$$

When it calculates similarly using this, the noise of the photographic subject of 5% of reflectance is as follows.
R: 25.5G: 29.9B: 28.3 [0033]Thus, a S/N ratio can be raised by making the absolute value of the coefficient of a linear matrix small. That is, the noise in the picture photoed by CCD can be reduced. There is a possibility that the chroma saturation of a low-intensity color may fall, by making the coefficient of a linear matrix small as the field where luminosity is low in this way. Then, in the field where luminosity is low, while making the absolute value of the coefficient of a linear matrix small, by enlarging the coefficient of a color difference matrix, the chroma saturation of a color is high and the low-intensity side can also acquire the picture which a colorless noise does not amplify. Namely, about the bright section (field where brightness is high) in a picture. The absolute value of the coefficient of a linear matrix is enlarged and the effect which could acquire the picture in which a noise cannot be easily conspicuous, and was more excellent in dark space by enlarging the coefficient of a color difference matrix while making the absolute value of the coefficient of a linear matrix small is acquired about dark space (field where brightness is low). What is necessary is just to make it how to divide a bright section and dark space divide with a predetermined threshold using value Y=3xR+6xG+B mentioned above.
[0034]When a matrix coefficient which only divides a bright section and dark space with a certain threshold, and is different about each in this way is given, there is a possibility that false contour may occur, in a portion from which brightness in a picture is changing continuously. Therefore, as for a matrix coefficient, it is preferred to make it change depending on the luminosity value Y defined by the above-mentioned value expression (1). For example, Ymax and the minimum are set to Ymin for the maximum of a luminosity value (Y value) in a picture, When a preset value with the largest absolute value of a matrix coefficient is set to aijmax, a preset value with the smallest absolute value is set to aijmin and a luminosity value of a noticed picture element in a picture is set to Y, it is good for the following formulas (6) to

determine each matrix coefficient aij.

$$aij = (aijmax - aijmin) \times (Y - Ymin)/(Ymax - Ymin) + aijmin \quad \ldots (6)$$

That is, a coefficient of a matrix is distributed proportionally according to a luminosity.

[0035]Although the above example was a case where a matrix coefficient was set up according to brightness, it may be made to set up a matrix coefficient according to a sensitivity preset value of a device. In this case, since sensitivity is highly set up so that sensitivity is so low that brightness is large and brightness is small, when sensitivity is low, A linear matrix coefficient sets up an absolute value greatly, and when sensitivity is high, while making it, as for a linear matrix coefficient, an absolute value become small, a coefficient of a color difference matrix is set up greatly. A noise contained in a picture photoed by CCD like the above by this can be reduced. The rest becomes possible [reducing a noise of an inputted image by CCD] by reading and using a program from this recording medium by recording an image acquisition method in an above embodiment on a recording medium as a program for performing a computer.

[0036]As mentioned above, although a recording medium which recorded a program for performing an image acquiring device using a solid state camera of this invention, an image acquisition method, and its method was explained in detail, As for this invention, in a range which is not limited to the above example and does not deviate from a gist of this invention, it is needless to say that various kinds of improvement and change may be made.

[0037]

[Effect of the Invention]According to this invention, the noise contained in the picture photoed with the solid state image pickup device, for example, CCD, can be reduced as explained above.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a block diagram showing the outline of the image acquiring device using the solid state image pickup device concerning one embodiment of this invention.

[Drawing 2]It is a diagram showing the spectral sensitivity characteristic of CCD of this embodiment.

[Description of Notations]

10 Image acquiring device

12 CCD

14 Data processing part

16 Brightness primary detecting element

18 Sensitivity set part

20 Matrix coefficient set part

22 Color correction part

24 Image output part